ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

PREMISES ENTRY RESTRICTION USING PROXIMITY CARD ACCESS CONTROL

P. O. Olagbegi[1] and B. A. Ugbi[2]

1. Department of Mechanical Engineering, Faculty of Engineering, University of Benin, P. M. B. 1154, Benin City, Nigeria.

2. Department of Mechanical Engineering, School of Civil, Mechanical and Aerospace, University of Manchester, Manchester, United Kingdom.

Manuscript Info

Manuscript History:

Received: 11 July 2013
Final Accepted: 26 July 2013
Published Online: August 2013

Abstract

This publication explores the possibility of using commonly sourced local materials in the design and installation of a road barrier with Proximity Card Access Control. This study was carried out at the Faculty of Engineering, University of Benin, Benin City, Edo State, Nigeria. The route used is the Engineering Access Road through 500 Lecture Theatre to University of Benin Staff School, which was formerly completely blocked off preventing staff from plying the route to and frotheir offices. Different methods were explored such as the use of retractable bollards and an operator controlled bollard. However, a rising arm bollard with necessary automatic controls was finally adopted.A screw jack was used to operate the raising arm mechanism because it is simpler but effective, more compact and involved the use of easily procurable components.An automated rising arm barrier with card, remote and call-in access controls was designed and installed on the Engineering access road which became accessible toauthorized staff via the card access control.

1.0 INTRODUCTION

Although we live in a civilized world, it has been a well-known fact that humans cannot always be counted on to instinctively act in accordance with rules or in ways beneficial to their fellow men. As such there is the need to control human behavior. In this modern age, many different methods for controlling human behavior in a vast number of scenarios have been employed. One of such scenarios is in the area of access to certain restricted areas. If such places are left open, without any form of control, anyone may access such areas. An extreme solution would be to completely block off this area, but this would also prevent authorized personnel from gaining access. Other methods such as '**STOP', 'NO ENTRY BEYOND HERE'** and **'AUTHORISED PERSONNEL ONLY'** signs have been employed with minimal success. One solution that showed an efficient level of control in the area of access by motor vehicle is the barrier system.

Vehicle movement through the Faculty of Engineering was restricted with a static barrier. This was because of disturbances caused by vehicles plying the route. This blocked off every vehicle passing through the Faculty including staff, especially those of Civil and Chemical Engineering from getting to their various offices through the normal route as well as Staff going to pick or drop off their kids at the Staff School of the University. The current barrier system employed in most Universitiesin Nigeria, particularly at the University of Benin, is the manually operated counter-weight type. This type of barrier possesses a number of draw backs; it relies on the use of manual labor, the operator must be present at all times and in all weather conditions for the system to functionwhichamounts toheavy labor on the individual required to push down the counter-weight. Another problem lies in human sentiment and access is at the operator's discretion.The operator has to a large extent autonomous control over who has access through the gate so he may decide to abandon his duty and allow unauthorized access to the area for his own selfish gain.

Of the different mechanisms that exist to operate the raising arm mechanism, a screw jack which when compared to other mechanisms; like the use of a hydraulic jack or a belt and pulley system was simpler and yet still effective, more compact and involved the use of easily procurable components was adopted. The raising arm barrier is a road barrier designed to control traffic by the lifting and lowering of the arm which crosses the road. This type falls under non-crash-resistant barriers and are distinct from crash- and attack-resistant barriers that are hardened barrier systems used to protect military, governmental, and other compounds and buildings of higher security levels. Non-crash-resistant barriers are "perceived impediments to access" and address the actions of two groups:

1. Persons who are law-abiding and comply with implied civil prescriptionsof behaviour as defined by the manner in which barriers are put to use; and
2. Others that are potentially threatening and disrupting for which barrier applications are *proscriptive* by notifying intruders their behaviour is anticipated and additional levels of security wait to identify them.

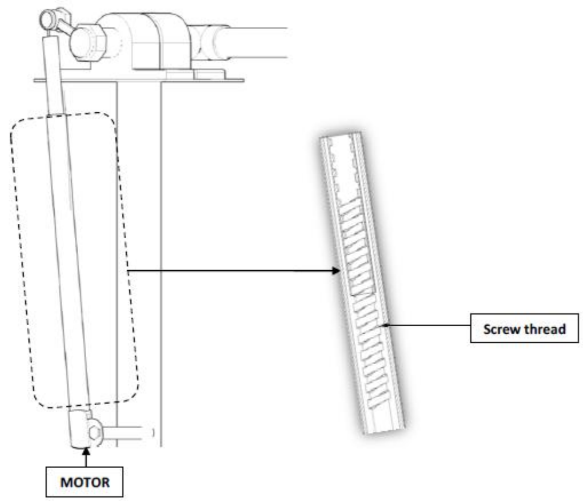
It is used in locations where it is needed to restrict access to particular classes of traffic or just as a check point. When used with an operator, it may be used as a toll gate point. It comprises of a raising arm, the lifting mechanism, the housing and road signs and symbols designed to inform the driver of the barrier ahead (Charles G. Oakes, 2011).

This system employs the use of proximity card readers, infrared motion sensors and a mechanized barrier as part of the *automated barrier system.* This system is void of human emotion and undeterred by rain or sunshine, would serve as a barrier to unauthorized vehicles and would at the same time allow only authorized personnel through. This *automated barrier* installation would serve the intent of the former barrier – blocking off non-staff, and still allowing staff to easily drive to their offices and Staff School through the Faculty of Engineering without the added disadvantages of the barrier system currently employed.

2.0 DESIGN AND SIZING

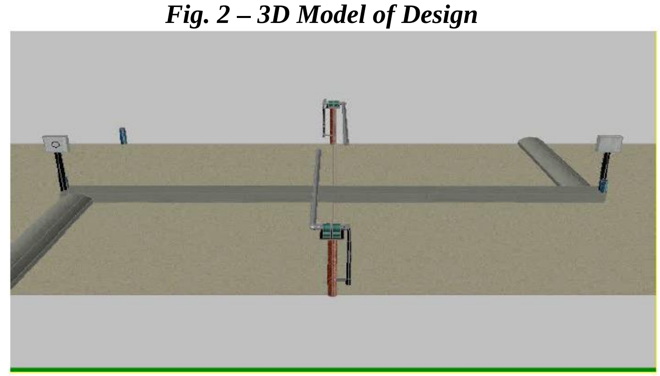
A screw is one of the six classical simple machines. It can convert a rotational motion to a linear motion, and a torque (rotational force) to a linear force. The most common form consists of a cylindrical shaft with helical grooves or ridges called threads around the outside. The screw passes through a hole in another object or medium, with stationary threads on the inside of the hole. When the screw is rotated relative to the stationary threads it moves along its axis relative to the medium surrounding it; for example rotating a woodscrew forces it into the direction of the applied force. Geometrically, a screw can be viewed as a narrow inclined plane wrapped around a shaft. Power screws convert the input rotation of an applied torque to the output translation of an axial force. The screw jack Mechanism in Figure 1 is an example of power screw.

Fig. 1 – The Screw Jack Mechanism



Here as the motor rotates, the power screw converts the rotary motion of the motor in to translational motion. The crank which is connected to the shaft (or crankshaft in this case) then converts this translational motion from the screw in to rotary motion which is used to raise and lower the barrier arm that undergoes a rotational motion. This design is compact, simple to design, easy to manufacture, requires no specialized machinery, large mechanical advantage, precise and accurate linear motion, smooth, quiet, and low maintenance, minimal number of parts, and most are self-locking.

Fig. 2 – 3D Model of Design



2.1 MODE OF OPERATION

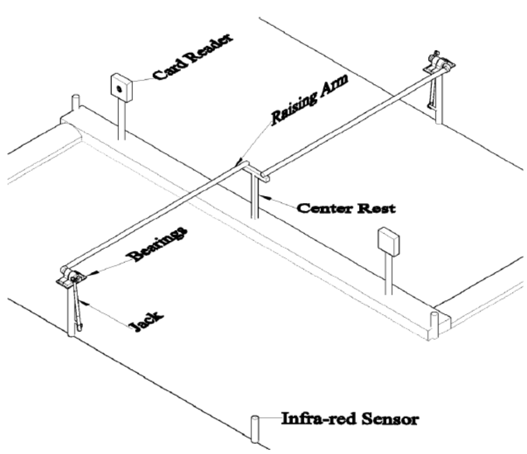
2.1.1 Mechanism

The mechanism employed is the crank mechanism which changes reciprocating motion to circular motion and vice versa. The end of the crank is attached to a pivot rod called the connecting rod. The end of the rod attached to the crank moves in circular motion, while the other end is usually constrained to move in a linear sliding motion in and out. The jack serves as the connecting rod; one end of the crank is attached to the jack while the other end is to a steel shaft. The linear (upward and downward) motion of the jack turns the crank thereby creating a circular motion of the shaft, and in turn an angular displacement of the rising arm.

2.1.2 Controls

The card reader and infrared sensors are connected to the two switches in the relay. Both switches are on when the relay coil is on and off respectively. On swiping the RF signal card on the card reader, signal is transmitted to the relays. The first relay is activated, which causes the motor in the screw jack to rotate. The linear motion of the jack is converted to circular motion with the use of crank.Breaking the infrared signal of the sensors activates the second relay. The circuit changes polarity causing the motor to rotate in the opposite direction.

Fig. 3 - Layout of the Automated Barrier System



2.2 MECHANICAL COMPONENTS SIZING

2.2.1 Crank

A *crank* is an arm attached at right angles to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It is used to change circular into reciprocating motion, or reciprocating into circular motion. The arm may be a bent portion of the shaft, or a separate arm attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod. The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion, in and out.

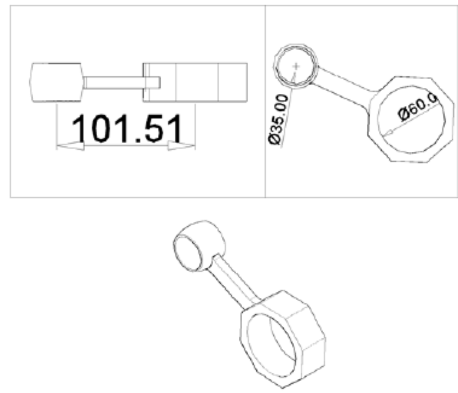


Fig. 4 – The Crank

2.2.2 Bearing

The shaft is to be held in a bearing, about which the arm and the crank would rotate.A pair of ball bearings is selectedto reduce friction as much as possible. A light bearing series used for moderated load and shaft sizes with the following parameters was selected:

Bearing Number: 212, Bore: 60mm,, Outer Diameter: 110mm and Width: 22mm.

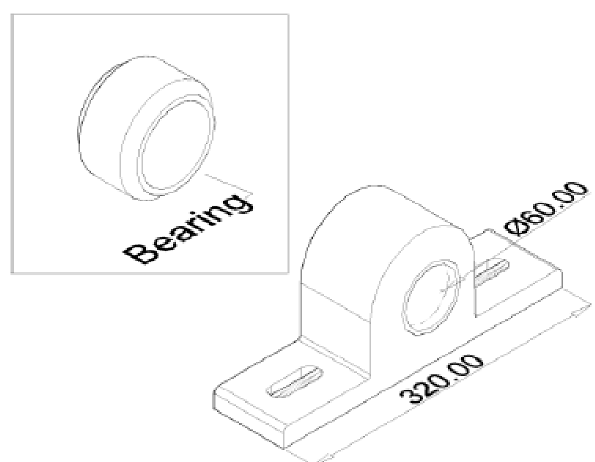


Fig. 5 – Pillow Bearing

2.2.3 Screw jack

A screw is a device that changes angular motion into linear motion, and usually, to transmits power. This is the prime mover of the mechanism and it transmits the force use to raise and lower the crossbar (barrier arm).

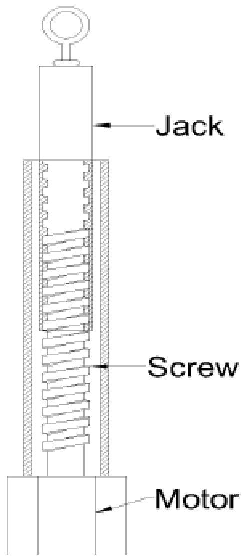
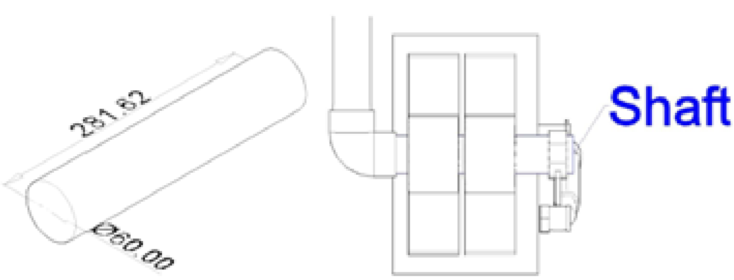


Fig. 6 – The Screw Jack

2.2.4 Shaft

The shaft is a rotating member, usually of circular cross-section used to transmit power or motion. It provides the angle of rotation of the crank and also controls the geometry of its motion. There is really no unique thing about the shaft that requires any special treatment. However because of the ubiquity of the shaft in so many machine design applications, there are some advantages of giving the shaft design a closer inspection. The shaft to be designed for is a solid shaft and the design consists primarily; the determination of the correct shaft diameter to ensure satisfactory strength and rigidity when the shaft is transmitting power under varying operational conditions. A 60mm diameter and 282mm length shaft is selected and it is designed to run through both bearings and to be connected to its ends by the elbow joint and the crank.

Fig. 7 – The Shaft and Layout



2.2.5 Cross Bar

The crossbar or barrier arm is the beam that is used to obstruct the traffic. Aluminum alloy is suitable for this purpose because of both its weight to strength ratio and its corrosion resistance.

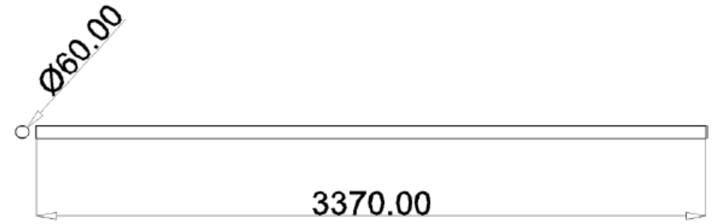


Fig. 8 – The Cross Bar

2.2.6 Elbow Joint

This is used to connect the crossbar (Barrier arm) to the crank mechanism (the crank and crankshaft) at 90^0. A steel elbow joint that would fit both the crossbar and the shaft is selected.

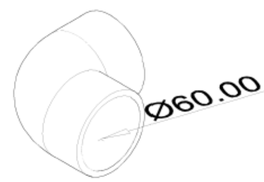


Fig. 9 – The Elbow Joint

2.2.7 Fasteners

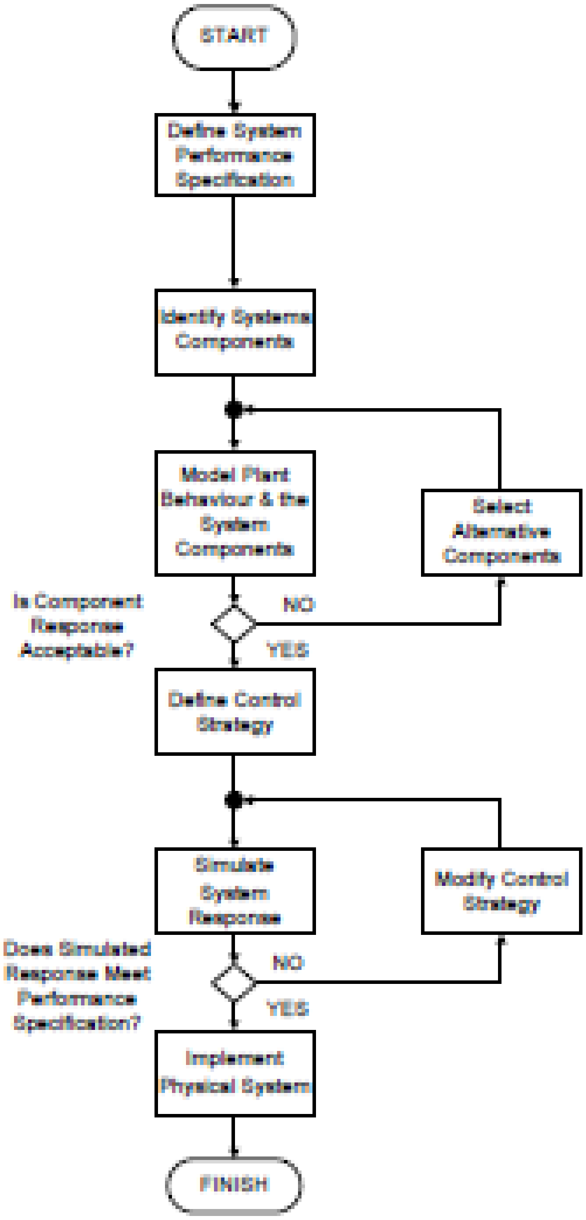
These are devices that are used to connect or join on or more components of an article or structure. There are thousands of fastener types and variations available. Bolts, nuts, washers, screws and bushings are used for this study.

2.3 CONTROL SYSTEM AND ELECTRICAL COMPONENTS SIZING

2.3.1 The Control Design Process

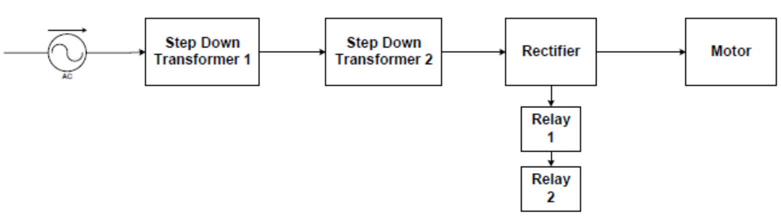
A control system is a device or set of devices to manage, command, direct or regulate the behavior of other devices or systems. The automated barrier system will have two outputs (to raise and lower the barrier arm) and two inputs; one from the card reader and the other from the infra-red sensors. The following standard methodology was applied to design the control system and it is represented on a flow chart shown in Figure 10.

Fig. 10 - Steps in Design of a Control System



2.3.2 The Flow Diagram

Fig. 11 – The Flow Diagram

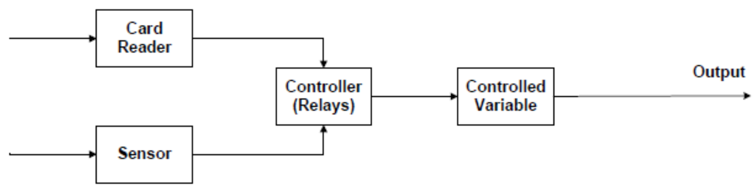


The power requirement for the motor is 50volts, so two step-down transformers was used to step the 240V to 55v which is enough for the motor to run; and a rectifier to convert the Alternating Current (AC) to Direct Current (DC) and from the rectifier the power is connected to the relays and motor.

2.3.3 Control Diagram

The control system design is an open loop control system that has two inputs and two outputs. The input devices are the Proximity Card Readers and the output devices are the Infrared Motion Sensors

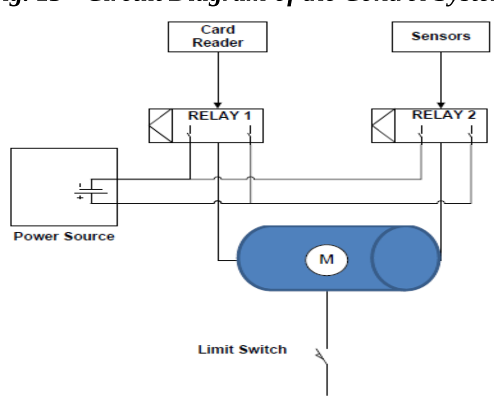
Fig. 12 - The Systems' Block Diagram



The proximity card reader and infrared sensors are connected to the positive and negative terminals. Each terminal is connected through a relay, transformer and rectifier to the motor of the power screw jack. The Proximity card reader is connected to one of the relays and the sensor is connected to the other relay. The relay then performs the intelligent switching between the two inputs. The sensors' relay is connected to the motor in the reverse direction of the connection of the card reader to make the motor rotate in the counter direction of the card reader and thus bringing down the crossbar. As the barrier arm or crossbar rises caused by the rotation of the motor the limit switch determines the maximum and minimum heights of crossbar. The limit switch in the motor is a mechanical device that open or close the circuit when the motor reaches its limit of travel. In other words, when the barrier arm reaches its maximum or minimum displacement, the limit switch breaks the circuit and the motor stops to rotate.

2.3.4 Circuit Diagram

Fig. 13 - Circuit Diagram of the Control System



2.3.5 Card Reader (Proximity Card Reader)

This is a device that reads signals from cards that has been programmed and then sends the signals to the relays. Proximity cards are powered by resonant inductive coupling via an LC circuit including an IC, capacitor and coil are connected in parallel. The card reader produces an electromagnetic field that excites the coil and resonant current charges the capacitor, which in turn energizes and power the IC.

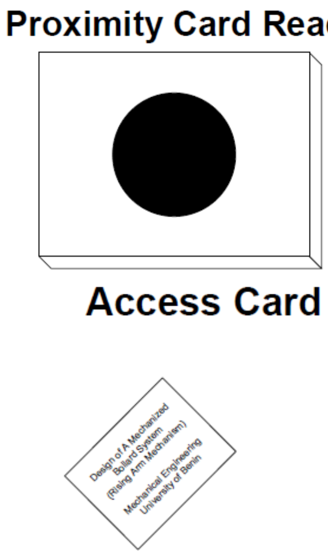


Fig. 14 - Proximity Card Reader with Access Card

3.0 DISCUSSION AND CONCLUSION

The automated barrier system was designed for use on the faculty of engineering access road. It has currently been installed and has been operational for over three months. One of the basic problemsencountered was getting the right material for the barrier for the best weight to rigidity ratio for the required length. A material that was very light so as to minimize power requirement and obtain maximum speed with also minimal deflection across a length of 11inches. To this effect a trial use ofPVC pipe was carried out which deflected excessively. A steel pipe was also used but the steel pipe was a lot more suitable than the PVC but it had the drawback of having a higher weight and consequently a lower speed than required. Finally,an aluminum pipe with a square cross-section was used. Due to aluminum's characteristic light weight and high strength and the improved geometry, it proved to have the best weight to rigidity ratio for the required length.

References

BBC. (2011, January 01). *History of the World*. Retrieved August 10, 2011, from BBC: http://www.bbc.co.uk/ahistoryoftheworld/objects/mu2RuLHgSEi6qqwRE5cdtg

Bristorm. (2010, March 15). *Entrance Protection Barrier With Raising and Swing Arms Roadblocker*. Retrieved April 10, 2011, from Bristorm: http://www.bristorm.com/entrance-protection-raising-and-swing-arms-roadblockers

Budynas-Nisbett. (2006). *Shigley's Mechanical Engineering Design* (8th ed.). United States of America: McGraw-Hill.

Burns, R. S. (2001). *Advanced Control Engineering*.London: Butterworth Heinmann.

Charles G. Oakes, P. (2011, February 16). *The Bollard*. Retrieved April 10, 2011, from WBDG Whole Building Drsign Guide: http://www.wbdg.org/bollard.php

Department Of Infrastructure, Energy And Resources (USA). (2008). *Road Safety Barriers Design Guide Part B.* U.S.A: Tasmania.

Ellis, G. (2004). *Control System Design Guide: A Practical Guide.* San Diego, California: Elsevier Academic Press.

Kuo, B. C. (1995). *Automatic Control System* (6th ed.). New Delhi: PHI Learning.

Kurmi, R. S. (2008). *Strength of Materials (Mechanics of Solid)* (26th ed.). New Delhi: S. Chand.

Microsoft Encarta (C). (2008, January 1). Electronics.Redmond, Redmond, United States of America.

Ogata, K. (2002). *Modern Control Engineering* (4th ed.). New Jersey, Upper Saddle River, United States of America: Prentice Hall.

Rajput, R. K. (2008). *Fluid Mechanics and Hydraulics Machine* (3rd ed.). New Delhi: S. Chand.

Shigley, J. E., &Mischke, C. R. (1996).*Standard Handbook of Machine Design* (6th ed.). U.S.A: McGraw-Hill.

Theraja, B. L. (2005). *A Textbook of Electrical Technology* (23rd ed.). New Delhi: S. Chand.

Wikipedia. (2010, May 26). *Bollard*. Retrieved March 15, 2011, from Wikipedia: http://en.wikipedia.org/wiki/Bollard

Wikipedia. (2011, May 05). *Bollard - Wikipedia, the free encyclopedia*. Retrieved July 2011, 2011, from Wikipedia: http://en.wikipedia.org/w/index.php?title=Bollard&action=edit

Wikipedia. (2011, July 29). *Relay*. Retrieved July 30, 2011, from Wikipedia: http://en.wikipedia.org/wiki/Relay

Wikipedia. (2011, July 23). *Sensor*. Retrieved August 10, 2011, from Wikipedia: http://en.wikipedia.org/wiki/Sensor"

Wikipedia. (2011, August 31). *Traffic Barrier*. Retrieved September 20, 2011, from Wikipedia: http://en.wikipedia.org/w/index.php?title=Traffic_barrier&oldid=447675529"

Wolfbeis, O. S. (2000). *"Fibre-optic chemical sensors and biosensors."*.USA: Anal Chem.

****